VSB TECHNICAL UNIVERSITY OF OSTRAVA | FACULTY OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE | DEPARTMENT OF COMPUTER SCIENCE

Algorithms for Big Data

Convolution Neural Network Model

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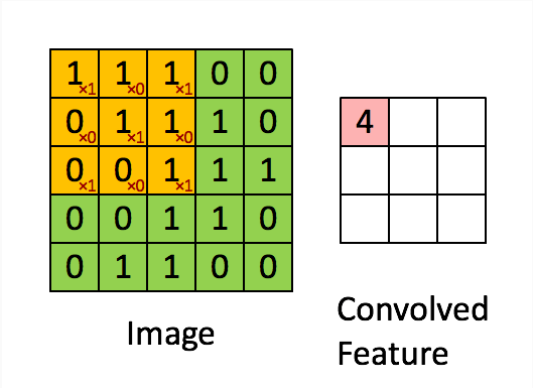
In image processing, *kernel* or *convolution matrix* or *mask* is a small matrix. In general the convolution in image processing is defined as:

$$g(x,y) = \omega * f(x,y) = \sum_{s=-a}^{a} \sum_{t=-b}^{b} \omega(s,t) f(x-s, y-t)$$

where $g(x,y)$ is filtered image, $f(x,y)$ is original image, ω if the filter kernel.

Convolution Neural Network

A kernel (also called a filter) is a smaller-sized matrix in comparison to the dimensions of the input image, that consists of real valued entries.



Sample Convolution Kernels

Identity

$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

Sobel vertical edge detection

$$\begin{bmatrix} +1 & 0 & -1 \\ +2 & 0 & -2 \\ +1 & 0 & -1 \end{bmatrix}$$

Sobel horizontal edge detection

$$\begin{bmatrix} +1 & +2 & +1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix}$$

Edge detection

$$\begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}$$

Sharpen

$$\begin{bmatrix} 0 & -1 & 0 \\ -1 & 5 & -1 \\ 0 & -1 & 0 \end{bmatrix}$$

Uniform blur

$$\frac{1}{9}\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$

Gaussian blur 3x3

$$\frac{1}{16}\begin{bmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{bmatrix}$$

Basic properties

Size of the kernel defines the dimensions of the kernels.

Number of input channels reflects the number of channels of the image (grayscale, RGB, etc.)

Number of output channels defines the number of kernels applied on the image, and, therefore, the output of the layer.

Stride is the size of the step that kernel is moved on the image.

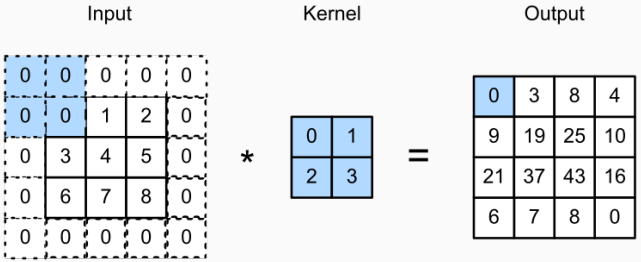
Padding is system the kernel is moder on the image.

Main advantage of the CNN

Weights sharing

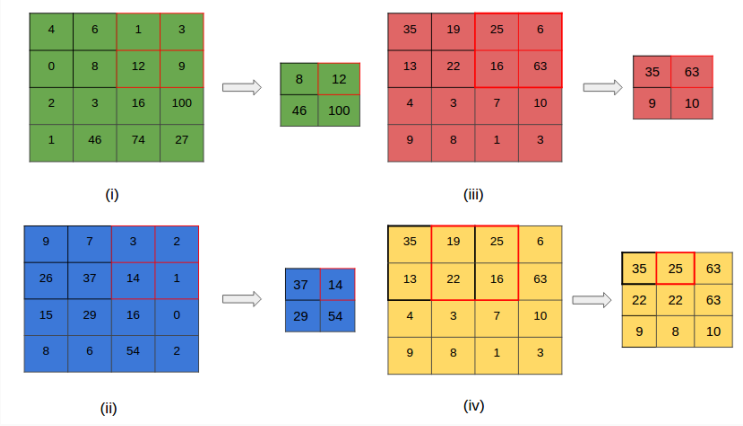
Padding

One tricky issue when applying convolutional is losing pixels on the edges of our image. A straightforward solution to this problem is to add extra pixels around the boundary of our input image, which increases the effective size of the image.



Pooling

Pooling is a way how to decrease the amount of information transfered from one layer to another. The standard way ho to do it is *Average Pooling* and *Maximum Pooling*.



Tensorflow Convolution Neural Networks

Tensorflow Convolution Neural Networks

- Structure of the Model
  1. Convolution
  2. Pooling
  3. ...
  4. Flatten
  5. Dense
  6. ...
  7. Dense (Softmax)

Tensorflow Convolution Neural Networks

- The input data requires special 3D shape for images (*width*, *height*, *channels*).
- The weights of each layer may be vizualized.
- The activations of each layer may be visualized.
- All regularizes (L1, L2, Dropout) may be used.
- The number of filter in each layer may be high.
- The pooling reduces the amount of data.

Questions?